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Consulting Scientists - Safety Philosophy & Technology

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February 13, 2006

Dallas W. Hartman
Dallas W. Hartman PC
2815 Wilmington Rd.
New Castle, PA 16105

Re: Lindquist v. Heim

Mr. Hartman:

Pursuant to your request we have reviewed and analyzed the materials provided to us in reference to the above captioned matter. Our initial opinions are contained in this report.

I. Materials Reviewed

- ANSI B11.3-1973
- ANSI B11.3-1982
- ANSI B11.3-2002
- ANSI B11.1-1971
- ANSI B11.1-1982
- Deposition of Tina Lindquist
- Deposition of Anthony Mase Jr.
- Deposition of Zygmund Zajdel
- Answers to Plaintiff's Interrogatories – Second Set and
- Request For Production of Documents – Second Request
- Heim Instructions and Parts Book
- Linemaster Product Literature/Catalogs
- Heim Product Literature
- Photographs
- Videotape

In addition to review of materials, Triodyne has completed an inspection of the Heim press brake as well as conducted footswitch experiments.

II. Accident Description

At the time of her accident, Ms. Tina Lindquist was the operator of a Heim Model 70-6 press brake at Corry Manufacturing. The operation being performed was the

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bending of a perforated exhaust piece about a mandrel. By mandate of Corry Manufacturing, this operation required the use of the Heim-supplied footswitch rather than the hand controls retrofitted by the employer, and also required that the operator use his or her hands to fit the stock piece to the mandrel. Footswitch control is selected by use of a supervisor's key.

It was during this hand-fitting of the stock piece that Ms. Lindquist's foot inadvertently and unintentionally entered the footswitch and activated the Heim press brake, causing devastating injury to Ms. Lindquist's hands.

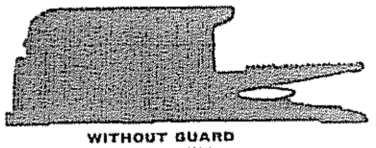
III. Identification

The press brake has been identified as a Heim Model 70-6, Serial 2176, sold in 1978 to HB Machinery and shipped to Avco Lycoming.

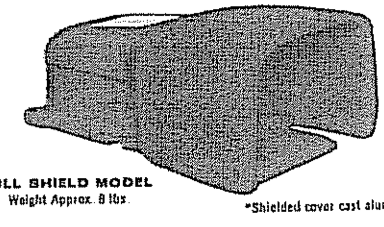
The manual for the subject machine illustrates a Linemaster footswitch, which, based upon the interrogatories/document production of Heim is a Model 532-SWH, a Hercules Heavy Duty footswitch with a "Full Shield." This is consistent with photographs of the subject footswitch after the accident.

Photographs taken of the accident footswitch illustrate a Linemaster footswitch which is not constructed with a safety gate. It is constructed with an antitrip treadle mechanism, a latch that requires a certain foot insertion into the switch to depress the pedal. Figure 1 below is a page from the 1977 Linemaster catalog which illustrates the Linemaster model shipped by Heim and used by Ms. Lindquist at the time of her accident.

HERCULES Heavy Duty Foot Switch



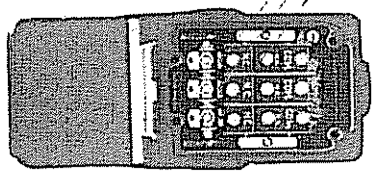
WITHOUT GUARD
Weight Approx. 6½ lbs



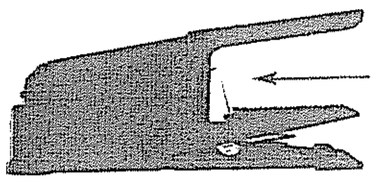
FULL SHIELD MODEL
Weight Approx. 8 lbs.

*Shielded cover cast aluminum

ADJUSTING SCREWS



EASY TO WIRE AND ADJUST



MAINTAINED LATCH UNDER GUARD

▶ Driptight ▶ Dusttight
▶ Watertight ▶ Oiltight
NEMA Types 2, 4 & 13

DIMENSIONS* 8⁹⁄₁₆" × 4⁹⁄₁₆" × 4½"

Weight Approx. 7½ lbs.

"O" SHIELD cover available for field installation on standard models. Catalog No. 534-E7, painted alert orange.

The rugged cast iron enclosure has sufficient weight to keep the switch from sliding across the floor when being operated. All Hercules switches have a ¾"-14 pipe thread conduit opening. Oiltight-watertight models have a neoprene cover gasket, plus a seal around the activating shaft. Separate #8 ground screw provided in all models. Alert orange finish. In all Maintained Contact Models the release is accomplished by simply pressing the latch with a light forward movement of the toe. This release is placed under the safety guard so falling objects cannot easily release it. In the two and three stage switches the sequence of latching can be selective if desired. In the standard models they are progressive.

SPECIFICATIONS WARNING See page 2

Dual ½"-14 pipe thread conduit opening models available.

OILTIGHT-WATERTIGHT			STAGE	CIRCUIT	ELECTRICAL RATINGS	COMMENTS
FULL SHIELD	"O" SHIELD	WITHOUT GUARD				
531-SWH 571-DWH	531-SWHO 571-DWHO	531-SWH 571-DWN	Single	SPDT	20 Amps 125-250 VAC 1 HP 125 250 VAC Heavy Pilot Duty 250 VAC Max.	Simple start and stop foot switch. Can be wired N.O., N.C. or SPDT
532-SWH 572-DWH	532-SWHO 572-DWHO	532-SWH 572-DWN	Single	DPDT		DPDT switch can also be adjusted so one circuit operates before the other.
533-SWH 573-DWH	533-SWHO 573-DWHO	533-SWH 573-DWH	Single	TPDT		TPDT switch can also be adjusted so 1 or 2 circuits operate before the 3rd.
534-SWH 574-DWH	534-SWHO 574-DWHO	534-SWH 574-DWH	Two	SPDT		Distinct "feel" between the two stages. Each stage SPDT.
535-SWH 575-DWH	535-SWHO 575-DWHO	535-SWH 575-DWH	Three	SPDT		Distinct "feel" between the three stages. Each stage SPDT.
536-SWH 576-DWH	536-SWHO 576-DWHO	536-SWH 576-DWH	Single	SPDT DB*	15 Amps 125-250 VAC ½ HP 125 VAC 1 HP 250 VAC Heavy Pilot Duty 250 VAC Max.	See comments above for adjustments and operational characteristics of similar models. *DB Double Break models have (4) four terminal interior snap switches and must be wired to equal voltage sources and the same polarity. The loads should be on the same sides of the line.
537-SWH 577-DWH	537-SWHO 577-DWHO	537-SWN 577-DWH	Single	DPDT DB*		
538-SWH 578-DWH	538-SWHO 578-DWHO	538-SWH 578-DWH	Two	SPDT DB*		

S Denotes MOMENTARY CONTACT—Press to Start—Release to Stop.
D Denotes MAINTAINED CONTACT—Press to Start—Press Latch to Stop.

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Oversize "O" SHIELD models available to accept oversized safety shoes and metatarsal foot guards.

Figure 1: The 1977 Hercules Heavy Duty Footswitch

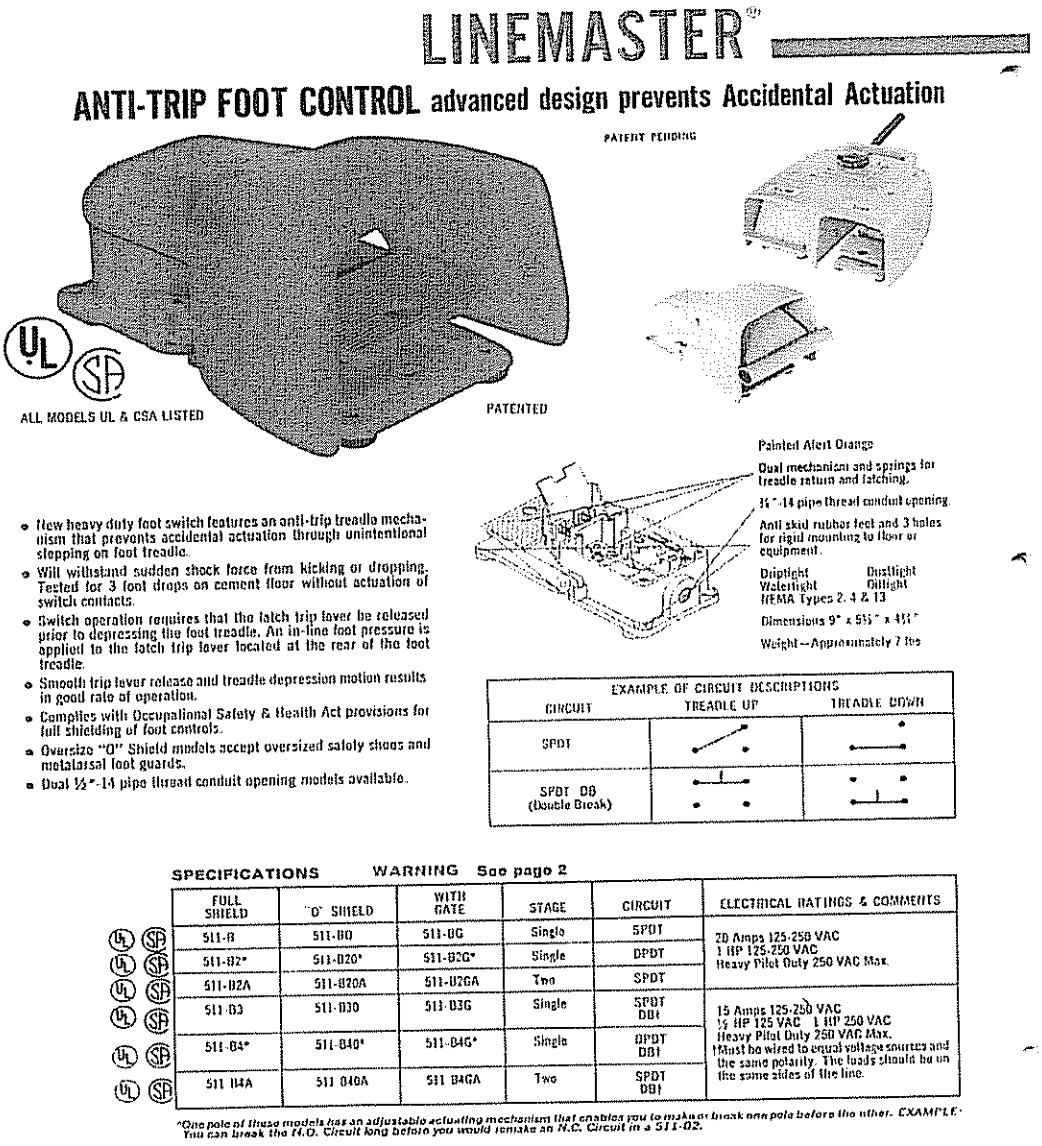
IV. The Linemaster Safety Footswitch

The Linemaster Switch Corporation introduced a safety footswitch for sale as a special order item in 1976. By May 1977, the safety footswitch was listed as a standard catalog item and consisted of the following features:

- A shield that covered the top and sides of the footswitch and came in two sizes to accommodate large workshoes.

- Anti-trip treadle latch mechanism that latches the pedal against activation by shallow insertions.
- A safety gate that must be raised to permit foot insertion.

The Anti-Trip Foot Control with Gate, which was advertised to prevent accidental activation, is illustrated at the top right in Figure 2, which depicts a page from the 1977 Linemaster catalog. As seen by the page numbers, Figure 2 is the page directly preceding the page shown in Figure 1.



LINEMASTER®

ANTI-TRIP FOOT CONTROL advanced design prevents Accidental Actuation

PATENT PENDING

ALL MODELS UL & CSA LISTED

PATENTED

Painted Alert Orange

Dual mechanism and springs for treadle return and latching.

½"-14 pipe thread conduit opening.

Anti skid rubber feet and 3 holes for rigid mounting to floor or equipment.

Driptight Dusttight
Watertight Oiltight
NEMA Types 2, 4 & 13

Dimensions 9" x 5½" x 4½"

Weight—Approximately 7 lbs

- New heavy duty foot switch features an anti-trip treadle mechanism that prevents accidental actuation through unintentional stepping on foot treadle.
- Will withstand sudden shock force from kicking or dropping. Tested for 3 foot drops on cement floor without actuation of switch contacts.
- Switch operation requires that the latch trip lever be released prior to depressing the foot treadle. An in-line foot pressure is applied to the latch trip lever located at the rear of the foot treadle.
- Smooth trip lever release and treadle depression motion results in good rate of operation.
- Complies with Occupational Safety & Health Act provisions for full shielding of foot controls.
- Oversize "O" Shield models accept oversized safety shoes and metatarsal foot guards.
- Dual ½"-14 pipe thread conduit opening models available.

EXAMPLE OF CIRCUIT DESCRIPTIONS

CIRCUIT	TREADLE UP	TREADLE DOWN
SPDT		
SPDT DB (Double Break)		

SPECIFICATIONS WARNING See page 2

FULL SHIELD	"O" SHIELD	WITH GATE	STAGE	CIRCUIT	ELECTRICAL RATINGS & COMMENTS
511-B	511-BO	511-BG	Single	SPDT	20 Amps 125-250 VAC 1 HP 125-250 VAC Heavy Pilot Duty 250 VAC Max.
511-B2*	511-B2O*	511-B2G*	Single	DPDT	
511-B2A	511-B2OA	511-B2GA	Two	SPDT	
511-B3	511-B3O	511-B3G	Single	SPDT DB†	15 Amps 125-250 VAC ½ HP 125 VAC 1 HP 250 VAC Heavy Pilot Duty 250 VAC Max. †Must be wired to equal voltage sources and the same polarity. The loads should be on the same sides of the line.
511-B4*	511-B4O*	511-B4G*	Single	DPDT DB†	
511-B4A	511-B4OA	511-B4GA	Two	SPDT DB†	

*One pole of these models has an adjustable actuating mechanism that enables you to make or break one pole before the other. EXAMPLE: You can break the N.O. Circuit long before you would remake an N.C. Circuit in a 511-B2.

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Figure 2: The 1977 Anti-Trip Foot Control with Gate Option

In 1977, Linemaster notified the marketplace of their new Anti-Trip models which included safety gates. They did this in their booth at the 1977 Design Engineering Show and they prepared a letter which they sent to their customers on May 31, 1977. These actions were a continuation of their efforts to produce the switch first produced by special order in 1976.

V. History

The Heim press brake which is the subject of the above captioned litigation was manufactured as a General-Purpose Mechanical Press Brake in 1978. The machine was designed to be activated by an electric foot control. At the time of manufacture the minimum requirements for the safety of press brakes were set forth in the American National Standard Safety Requirements for the Construction, Care, and Use of Power Press Brakes, ANSI B11.3-1973. This document is the first ANSI standard developed specifically for press brakes. As such, it only addressed mechanical foot pedals. Every illustration in ANSI B11.3-1973 that depicts a foot control has been assembled in Appendix A of this report.

It may be observed in Appendix A that Illustrations 1, 3, 12, 13, and 23 show a horizontal foot treadle shaft that allows the foot pedal to be located anywhere along the bed of the press brake. Illustration 14 indicates that the pedal is both removable and adjustable. Furthermore, a locking lever is depicted that will prevent any activation of the press. A locking pin is shown in Illustration 15 that serves the same purpose as the locking lever.

Paragraph 4.2.4.1.4 from the standard sets out the philosophical position of the industry with respect to accidental activation of foot-pedals:

> *4.2.4.1.4 Foot-Pedal Actuation Prevention*
> **When a foot pedal is furnished with the press brake, a means shall be provided for preventing any accidental operation of the press brake.**

With the explanation E 4.2.4.1.4 next to it as:

> E 4.2.4.1.4 Foot-Pedal Actuation Prevention.
> Two methods of fulfilling this requirement are:
> (1) Removing the foot pedal and placing it in a safe location
> (2) Providing a locking pin or locking lever, as noted in Illustration 14. These locking mechanisms should be designed to inhibit accidental actuation, but not to allow

> locking in the operating position. For additional operator safety in foot-pedal-type operations, it is recommended that the locking device (pin or lever) be used to prevent actuation of the press brake when not in operation.

Illustration 15, in addition to the locking pin, portrays a barrier guard disposed around the foot pedal. The guard serves to minimize accidental activation of the foot control which is called for in paragraph 4.2.4.2.4:

> *4.2.4.2.4 Foot-Control Actuation Prevention.*
> **The foot control shall be protected so as to inhibit accidental activation by falling or moving objects, or by someone stepping on it. Means shall be provided for manually locking the foot control to inhibit such accidental actuation.**

With the accompanying explanation E 4.2.4.2.4:

> E 4.2.4.2.4 Foot-Control Actuation Prevention
> One way of preventing or inhibiting accidental actuation of the foot control would be to provide a key-operated selector switch. Another way of providing against accidental activation is shown in Illustration 15.

As a final observation, Appendix A suggests that the undepressed foot pedals are elevated 5 to 7 inches above the floor surface. This implies that an operator can never walk onto the foot pedal. Vintage 1970 mechanical foot pedals required an activation force between 25 and 40 lbs. Further, the activation stroke of the pedal at that time was between 2 and 3 inches.

In summary, classical press brakes minimized accidental activation of their mechanical foot controls through their high activation force thresholds and large activation displacements coupled with restricted locations near the bed, barrier protection and large elevations above the work/walking surface. Every one of these features were radically compromised by the introduction of electric foot controls. These foot switches were tethered on long electric cords which enabled them to be under foot anywhere in front of the press brake. They present a "hair trigger" with activation resistance between 5 and 12 lbs together with a ¼ inch activation displacement. The electric foot switch pedal is usually 1 to 1 ½ inches above the floor which enables most people to walk directly onto the pad. A normal

walking gait lifts the toe from 1 ¼ to 2 ½ inches above the walking surface.

VI. Human Factors Investigation of Accidental Footswitch Activation

To study the characteristics of the Linemaster footswitch that was adopted by Heim, a number of male and female candidates were called upon to adopt resting positions in front of a footswitch that would normally be used for activating a machine, a Linemaster 511-B2.

Specifically, an operator was requested to put his or her right foot into the switch in an activation position while the left foot equilibrated in a position even with the activating foot. This results in an effective activation geometry so that balance can be maintained while activation and deactivation proceeds. In periods where the footswitch is not to be activated, the foot is removed from the footswitch and placed on the working surface while leaving the stabilizing left foot in position. Consequently, two equilibrium positions were developed: a rest equilibrium and an activation equilibrium with the left foot in a fixed position.

To study the propensity of the footswitch for accidental activation, operators were asked to begin in the activation position, step rearward with their right foot to the rest position, and then to move forward from the rest equilibrium position without looking at the footswitch or intending to activate the footswitch. If the switch was activated by this stepping forward, a light was illuminated and counted as an accidental activation.

Five males and five females were tested and videotaped for an arbitrary amount of equilibrium shifts. In 93 forward motions, there were 87 accidental activations.

Using the same method and candidates, a Linemaster 511-BG, a footswitch with a safety gate, was tested. All 96 forward motions were universally unsuccessful in causing an accidental activation.

The subject Heim press brake was unreasonably dangerous because the original Linemaster 532-SWH footswitch which was shipped with the press brake allows accidental activation under a reasonably foreseeable operating profile. On the other hand, the Linemaster switch with the safety gate, of the Anti-Trip G series, eliminates accidental activation by a blind stepping motion, and would clearly have prevented the injury of Ms. Lindquist.

Recall that Linemaster offered the gated footswitch by special order in 1976, and as a regular catalog item in 1977 while the subject machine was sold by Heim in 1978.

The Heim press brake is not capable of continuous operation and requires the footswitch to be activated in order to cause the machine to cycle. When the operator places a part into the die or removes a part from the die, it is necessary to reach forward, and/or step forward to promote this activity. Unfortunately it is this forward motion that gives rise to accidental activation of the ungated switch at the very time that the hands are in jeopardy.

VII. Punch Press vs. Press Brake

Unlike the punch press, the press brake almost always has the workpiece manually set and the finished product removed without the aid of mechanical contrivances. It is reasonably foreseeable to manufacturers of press brakes that the loading and unloading of workpieces will be done by hand.

One of the characteristics of press brakes that differ from punch presses is the notion that very few press brakes have point of operation guards or devices. The standard gives permission to use pullback devices, restraining devices, barrier guards and presence sensing devices. In 1973, at the time the B11.3 standard was written, almost no press brakes were equipped with point of operation devices. Even today these machines are primarily protected by two-hand controls or light curtains when they are compatible with the operation. For this reason, accidental activation of the foot control on press brakes is particularly devastating.

As a historical note, on a properly guarded punch press, accidental activation of a foot control will not lead to an injury.

VIII. Accidental Activation

Because machines magnify the strength of humankind, it is imperative that they remain under control. The machine should go only when we want it to go, and should stop and remain stopped when so desired. Obviously, accidental activation of a control violates the basic control philosophy for machines.

The ANSI B11.3-1973 standard is very clear that they want accidental activation eliminated where possible and minimized where elimination is not possible. This notion is entirely consistent with the general field of safety which speaks to this issue. Appendix

B contains annotations from various sources that make it very clear that the safety community wants accidental activation brought under strict control.

IX. "Hands Out Of Die" (HOOD)

It is our understanding that Heim has taken a position that HOOD (Hands Out Of Die) is an effective safety concept. Indeed, an on-product warning sign mounted on the front of the press brake contains the following admonition:

NEVER PLACE ANY PART OF YOUR BODY UNDER THE RAM
OR WITHIN THE DIE AREA

The warning sign also states that it is the employers responsibility to implement this.

In B11.3-1973, the first press brake standard adopted the HOOD philosophy as one of their four objectives. Indeed, this was a general idea proposed throughout the B11 committees with all their respective machinery.

The difficulty in implementing this concept was so overwhelming that the B11.1-1982 standard for power presses placed the following disclaimer in the forward:

> The philosophy underlying the 1971 standard was HOOD (Hands Out Of Die) operation. After the adoption of the 1971 standard by ANSI and its incorporation into OSHA regulations, many employers documented an absolute inability to meet the HOOD objective. Accordingly, OSHA in 1974 modified that as a requirement, and this version of the standard incorporates that modification

The shortcomings of the HOOD philosophy were outlined by OSHA as part of their revocation of HOOD as an OSHA requirement in 1974. For example, excerpts from the Federal Register, Vol. 39, No. 233, on December 3, 1974:

> Those supporting revocation of mandatory 'no hands in dies' based their support upon: (1) the lack of statistical evidence showing that 'no hands in dies' is necessary or appropriate to protect employees from point of operation hazards; (2) the availability of safeguarding devices which will protect employees from point of operation hazards, while permitting 'hands in dies'; (3) the additional hazards created by the devices which would be substituted for

> manual feeding; (4) the high cost associated with implementing 'no hands in dies'; and (5) the technological infeasibility of 'no hands in dies' on some production runs.
>
> ...
>
> This requirement would not have prohibited or prevented employees from actually placing their hands in the point of operation. Indeed, point of operation injuries occur where 'no hands in dies' is in effect.
>
> ...
>
> In addition to the potential for point of operation injures which exists even with 'no hands in dies,' additional hazards are created in 'no hands in dies' operations. Thus serious additional pinch points are created by feeding apparatus.
>
> ...
>
> Technologically, 'no hands in dies' does not appear to be universally possible in the near future....Therefore, it clearly appears that a universal requirement of 'no hands in dies' would be infeasible.
>
> We also believe that the costs associated with attaining 'no hands in dies' are prohibitive....
>
> It has further been suggested, and we agree that the costs of instituting 'no hands in dies' would make many short production runs economically infeasible....
>
> For the above reasons, we have revoked the requirement of 'no hands in dies.'

In summary, it is reasonably foreseeable that the HOOD philosophy would not have prevented the injury to Ms. Lindquist.

X. Conclusions

A. It can be expected that an operator can accidentally move his or her feet in a trajectory that could inadvertently contact the footswitch. That is, the same motion for deliberate action using the open faced footswitch is easily performed accidentally through a normal forward stepping motion.

B.. The adoption of an electric foot control was a major departure from the mechanical foot pedal which displayed so many important features for minimizing accidental activation. Specifically, mechanical foot pedals operated in a somewhat restricted location close to the bed; they had large activation resistance and required large pedal movements to activate the ram.

The mechanical controls were disposed over 6 inches off of the working surface, minimizing the chance of accidentally walking onto a pedal. These controls could be deactivated by locking levers, locking pins and by physical removal of the pedal itself.

C. The electric foot controls in general, and specifically the Linemaster full shield model selected by Heim, were tethered on electric cords which allow them to be placed anywhere in front of the press.

The Linemaster 511B2 used in our human factors testing can be characterized as having a 6 ½ lb. activating force and an activating displacement of ¼ inch. The pedal rests 1 ½ inches from the floor

These combined characteristics make an electric footswitch extremely sensitive to accidental activation.

D. At the time the subject press brake was delivered, there were gated electric footswitches available on the market specifically intended to prevent accidental actuation. This includes the Linemaster Switch Corporation's Anti Tip Footswitch with Gate.

This protected switch was available two years before the sale of the machine, and could be found in the Linemaster catalog page directly opposite of the switch that was improperly selected by Heim.

Heim elected to continue incorporating the less expensive and less safe foot control into their press brake system.

E. Human factors experiments conclusively demonstrate the efficacy of a gated Linemaster footswitch.

Head to head comparisons of a Linemaster open front "Full Shield" model and a gated Linemaster safety footswitch indicated a 0% accidental activation rate for the gated control, and a 93.5% accidental activation rate for the ungated model

F. The Heim press brake system that was sold in 1978 was defective and unreasonably dangerous and proximately caused the brutal injury suffered by Ms. Tina Lindquist.

This report contains initial opinions, and we reserve the right to amend this report in the face of further information.

Please do not hesitate to contact Triodyne, Inc. if we can be of further assistance.

Respectfully submitted,

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